Hastings Environmental Law Journal

Volume 7
Number 2 *Winter 2001*

Article 2

1-1-2001

Geothermal Energy: Is It Attractive Enough to Draw Investors for Construction of Geothermal Electric Plants?

Kaveh Badiei

Geothermal Energy:

Is It Attractive Enough to Draw Investors for Construction of Geothermal Electric Plants?

By *Kaveh Badiei*⊕

I. Introduction

There are numerous methods of producing electricity. Hydro-energy, natural gas, nuclear, solar and wind energy, fossil fuels and geothermal energy are just a few means of electricity production. When Congress adopted the Public Utility Regulatory Policy Act of 1978 (PURPA)[1], renewable energies, including geothermal energy, gained immense popularity. In fact, since PURPA, "there have been a multitude of innovations in [renewable energy] technologies that have lowered their cost and increased their reliability."[2] They have become so reliable that a recent report by the Geothermal Energy Association noted that in the next decade seventeen percent of the world's population could receive their electricity from a geothermal source.[3] In California, up to thirty percent of the state's power consumption could become dependent on geothermal energy.[4] California also has a $540 million fund which supports renewable energies, such as geothermal, in power generation.[5]

⊕ J.D. (expected), University of California, Hastings College of the Law, 2001; B.S., University of California, Irvine, 1997. The author wishes to thank the 2000-01 *West-Northwest* Editorial Board and members for their input. The author expresses special thanks to his family and his fiancee for their constant love and support.

1. PUB. L. NO. 95-617, 92 Stat. 3117 (codified in scattered sections of 15, 16 & 30 U.S.C.).

2. *Federal Tax Issues Relating to Restructuring of the Electric Power Industry: Hearing Before the Subcomm. on Long-Term Growth and Debt Reduction of the Senate Fin. Comm.*, 106th Cong. 45 (Oct. 19, 1999) (statement of William Carlson, Chairman, Renewable Comm. of the Electric Power Supply Assoc. and Vice President, Wheelabrator Environmental Systems, Anderson, Cal.).

3. *Business and the Economy Alternative Energy: Study Shows Geothermal Potential*, AMERICAN POLITICAL NETWORK, Apr. 9, 1999 (providing that "geothermal plants could produce about 8.3% of the world's electricity needs and 'greatly reduce' air pollution and global warming problems, according to a report by the Geothermal Energy Assn. released on 4/7"). The survey also found that "[thirty-nine] nations, with [seventeen percent] of the world's population, could produce all of their electricity from geothermal generators." *Id.*

4. *Id.*

5. Mark Henry, *Davis Praises Desert Wind-Turbine Project: Sixty-Two Units More than Twice as Tall as the 477 That They Will Replace Are to be Built South of Interstate 10 in the Palm Springs Area*, PRESS-ENTERPRISE (Riverside, Cal.), Nov. 18, 1999, at B1 (reporting that "the California Energy Commission has a $540 million fund to support renewable energy, such as wind farm and geothermal hydroelectric plants. [Governor] Davis said he would like to increase that amount in next year's budget").

Following in the footsteps of the California Energy Commission, the Department of Energy has spent $28.5 million on innovative methods of tapping geothermal energy.[6] The Department of Energy is also encouraging the use of geothermal energy in meeting fast increasing electricity demands by funding geothermal research.[7] Moreover, recent legislation has given consumers incentives to purchase "green electricity."[8]

Geothermal energy continues to be considered a cheap, renewable and environmentally friendly source for production of electricity.[9] This Note seeks to examine its potential from the perspective of investors and developers. That is, are there enough legal, political, environmental, social and economic incentives to encourage an increase in construction and implementation of power production from geothermal energy, or will geothermal energy remain just another "green" energy source on paper?

Section II provides an overview of methods and the environmental impacts of producing electricity from a geothermal source. Section III surveys the current laws governing geothermal energy and its developments. Finally, in Section IV, financial aspects of constructing, implementing and maintaining a geothermal electric plant are examined to answer the question posed above.

II. Background

This section discusses the development and use of geothermal energy. Part A provides a brief history and the technical method of converting geothermal energy to electricity. In Part B, both known and speculative environmental impacts of using geothermal energy are explained.

A. Technical Method of Converting Geothermal Energy to Electricity

In a nutshell, geothermal energy is heat derived from the Earth.[10] Such heat is produced by "conductive flow of heat through solid rocks, by convective flow in circulating fluids, or by mass transfer in magma."[11] Conductive flow through solid rocks is achieved by transfer of heat from the surface of the Earth to its core. However, increase in temperature is not always proportional to the increase in depth because "conductivity of rocks differs greatly with depth as functions of mineralogy, porosity, and fluid content of pores."[12]

Convective flow in circulating fluids is the second method of geothermal heat production.[13] The natural occurrence of convection is due to the "heating and consequent thermal expansion of fluids in a gravity field."[14] There are two types of hydrothermal convection: hot-water systems and vapor-dominated systems.[15] In the hot-water system, "[w]ater . . . serves as the medium by which heat is transferred from deep sources to a geothermal reservoir at shal-

6. Inside Energy/With Federal Lands, The Electricity Generation Potential from Geothermal Resources, Apr. 12, 1999 (stating that the Department of Energy is "spending $28.5 million on geothermal [research and development] in [fiscal year 1999] and has requested $29.5 million for the effort in [fiscal year 2000]").

7. Bart Jansen, *Richardson Proposes Expanding Geothermal Power, Grants*, ASSOCIATED PRESS NEWSWIRES, Jan. 24, 2000.

8. *See* S.E. Hamilton, *People of Color Should Make Green Energy a Priority*, SUN-SENTINEL, Nov. 15, 1999, at 23A (reporting that before the deregulation of the electric industry, "consumers had no choice but to purchase electricity made from fossil fuels . . . . But now, in California and in Pennsylvania, customers can insist that their home be lit the green way — from the sun, wind and geo-thermal steam").

9. *See, e.g.*, Lee Davidson, *Clean and Green: Geothermal Power Could Cut Pollution*, DESERET NEWS, Apr. 7, 1999, at A1 (quoting P. Michael Wright, deputy director of the University of Utah's Energy & Geoscience Institute, in that "geothermal power plants are very, very clean compared to coal, oil and natural gas"); *see also Unocal To Sell Stake In Steam Venture To Calpine For $101 Million*, DOW JONES BUSINESS NEWS, Jan. 26, 1999 (reporting that "[g]eothermal power, which uses steam from under the Earth's surface to power turbines, is one of the cheapest forms of environmentally clean electricity").

10. DANIEL DEUDNEY & CHRISTOPHER FLAVIN, RENEWABLE ENERGY: THE POWER TO CHOOSE 218 (1983) (defining geothermal energy as energy which "comes directly from the earth's vast subsurface storehouse of heat").

11. DONALD E. WHITE, *Characteristics of Geothermal Resources*, in GEOTHERMAL ENERGY: RESOURCES, PRODUCTION, STIMULATION 69, 71 (Paul Kruger & Carel Otte eds., Stanford University Press, 1973).

12. *Id.* at 72.

13. *Id.* at 74.

14. *Id.*

15. *Id.* at 75, 82.

lower depths."[16] Water circulating beneath the surface of the Earth is "heated by conduction from hot rocks that, in turn, are probably heated by molten rock."[17] Once the groundwater has been heated, depending on the geology of the area, it can either dissipate at the surface as hot-water springs or it can be stored as geothermal energy below the impeding rock formations.[18]

The other category of hydrothermal convection system is the vapor-dominated system. There, heat is derived from "dry or superheated steam with no associated liquid."[19] This type of system, also known as the "dry steam" system, is "develop[ed] initially from hot-water systems characterized by very high heat supply and very low rates of [groundwater] recharge."[20] Hence, "when the heat supply of a developing system becomes great enough to boil off more water than is being replaced by recharge, a vapor-dominated reservoir begins to form."[21]

Having briefly explained the phenomenon of geothermal energy, generating electricity from such source also requires an overview. Generally, there are two methods of production: steam flash process and binary process.[22] When a steam flash process is the mode of production, a "steam separator[] . . . take[s] the steam from a flashing geothermal well and passes the steam through a turbine that drives an electric generator."[23]

The second method of converting geothermal heat to electricity is the binary process. In a binary process, the "pressurized geothermal brine yields its heat energy to a second fluid in heat exchangers."[24] The second fluid, which becomes vaporized in the heat exchangers, "passes through a turbine that drives an electric generator."[25] After this exchange of energy, the geothermal brine is pumped back into the reservoir and the vapor exhaust of the secondary fluid is recycled back into the heat exchanger.[26]

B. Environmental Impacts of Geothermal Power Generation

Conversion of geothermal heat to electricity, like any other source, does have its adverse environmental impacts. In fact, corporations hoping to utilize geothermal energy in power production have met firm environmental opposition. A recent example is the proposal for two plants in Northern California.[27] According to Felice Pace of the Klamath Forest Alliance, an environmental group challenging the construction of two geothermal projects, "the plants will further carve up forests in Siskiyou County and [are opposed by] Indians who consider the sites to be part of their sacred lands."[28] Moreover, "because the two energy companies acknowledge that they can tap into the land's geothermal heat for about fifty years, not indefinitely, the plants are not really sustaining. Also,. . . the two plants will further damage some of the . . . habitat for endangered species."[29]

Geothermal power plants have particular impacts on the land, air and water.[30] They can also cause noise pollution in areas surrounding the plants.[31] The effects on land are caused by the way the wells, pipelines and the plant itself alter the existing terrain.[32] That is, because the location of the plants is usually a secluded wilderness, the exposed piping and

16. *Id.* at 75.

17. *Id.* at 77.

18. *Id.*

19. *Id.* at 82.

20. *Id.*

21. *Id.*

22. 8 McGRAW-HILL ENCYCLOPEDIA OF SCIENCE & TECHNOLOGY Geothermal Power 72, 74 (7th ed. 1992).

23. *Id.*

24. *Id.*

25. *Id.*

26. *Id.*

27. Ken Hoover, *Opposition to 2 Geothermal Proposals: Foes Say Siskiyou County Power Plants Would Harm Land, Defile Tribal Sites*, S.F. CHRONICLE, Sept. 13, 1999, at A20.

28. *Id.*

29. *Id.*

30. RICHARD G. BOWEN, *Environmental Impact of Geothermal Development*, *in* GEOTHERMAL ENERGY: RESOURCES, PRODUCTION, STIMULATION 197, 200, 207, 211 (Paul Kruger & Carel Otte eds., 1973)

31. MICHAEL K. LINDSEY & PAUL SUPTON, STANFORD ENVIRONMENTAL LAW SOCIETY, GEOTHERMAL ENERGY: LEGAL PROBLEMS OF RESOURCES DEVELOPMENT 31(1975); *see also* BOWEN, *supra* note 30, at 200.

32. BOWEN, *supra* note 30, at 200.

wells that carry geothermal energy change the scenery and harmony of the terrain.

The hot water that is pumped out of a geothermal reservoir can also have a detrimental effect on the land. Groundwater, which is the source of the hot water, carries a considerable portion of the ground load. Thus, support provided for anything on the surface of the earth in the surrounding area is partially supported by the groundwater. Accordingly, removal of such groundwater would result in ground-settlement and loss of support for load applied at the surface.[33] However, this phenomenon, known as "subsidence,"[34] could be remedied by injecting water back into the reservoir.[35] Moreover, thermal energy derived from dry-steam will not be faced with such a problem since no groundwater exits at such reservoirs.[36]

Geothermal power plants also have an impact on air quality. However, because geothermal plants operate "without combustion, the volume of noxious gases produced is far less and is of a different nature than that from a fossil-fuel plant."[37] In fact, gases emitted are mainly water vapor.[38] Nevertheless, the emission of the steam does add to the concentration of hydrogen sulfide[39] and carbon dioxide[40] in the atmosphere.[41] With the right procedures, however, 99.9% of the hydrogen sulfide could be eliminated.[42]

Surface water is yet another natural resource that is adversely affected by geothermal utilization. Pollution occurs when the geothermal heat used to generate electricity is injected into a body of water.[43] The thermal pollution "can cause local environmental degradation."[44] This result can be avoided if cooling towers are used to reduce the temperature of the brine that is rejected into the local body of water.[45] However, since cooling towers use local running water as the cooling device, the "plants will cause a severe strain on the available water resource."[46]

Another environmental impact of geothermal energy is the injection of geothermal brine.[47] The high temperature of the brine increases the "rate of dissolution of the more volatile chemicals of the host rocks."[48] Thus, addition of the brine to the groundwater aquifers would increase the impurities. However, "in many cases the thermal waters are of sufficient purity to be used for agricultural and industrial purposes."[49]

III. Legal Constraints on Geothermal Energy

A developer seeking to convert geothermal energy to electricity should be intimately familiar with several areas of law — specifically, real property and water,[50] environmental,[51] and tax.[52] Before the role of each body of law is

33. *Id.* at 202. Note that "load" could be from the weight of vegetation, trees, or any man-made structure.

34. *Id.*

35. *Id.* at 204.

36. *See, e.g.*, DEUDNEY & FLAVIN, *supra* note 10, at 90; BOWEN, *supra* note 30, at 201, 202; LINDSEY & SUPTON, *supra* note 31, at 29.

37. BOWEN, *supra* note 30, at 207-08.

38. *Id.* at 208.

39. The environmentally unfriendly impacts of hydrogen sulfide include foul odor, acid rain (when hydrogen sulfide is entered into the atmosphere, it is converted to sulfur dioxide which is the source for acid rain), and neurological damage to humans if the concentration is high enough.

40. Some environmentalists believe that the emission of carbon dioxide contributes to global warming or the "greenhouse effect."

41. *Id.* at 208-09. A comparison between a 1000-MW geothermal plant and a fossil fuel plant has revealed that while a geothermal plant produces 48.4 tons of hydrogen sulfide per day, the plant operated by fossil fuel would produce 140 tons of sulfur dioxide per day. The same comparison also shows that a geothermal plant releases 860 tons of carbon dioxide per day while a fossil fuel plant would emit 20,000 tons of carbon dioxide per day. *Id.*

42. Marshall J. Reed & Joel L. Renner, *Environmental Compatibility of Geothermal Energy*, U.S. Department of Energy Geothermal Energy Technical Site, *at* http://id.inel.gov/geothermal/articles/reed/index.html (last modified Sept. 29, 1997) (providing that 99.9% of hydrogen sulfide can be removed either by the "Stretford process or the incineration and injection process").

43. BOWEN, *supra* note 30, at 210.

44. *Id.*

45. *Id.*

46. *Id.*

47. *Id.* at 211.

48. *Id.* at 212.

49. *Id.*

50. *See infra* Part III.B.

51. *See infra* Part III.C.

52. *See infra* Part III.D.

explained, however, a brief background of the development of geothermal laws is provided.

A. Development of Geothermal Energy Laws

Generally, the government has four distinct interests in implementing laws that govern an energy source.[53] The first of such interests is the concern for health and safety.[54] This concern extends not only to humans but also to the "natural environment."[55] The second governmental interest is the "economic regulation of the energy industries."[56] Since federal and state laws "define[] gas, electricity, and portions of the transportation industry as statutory monopolies regulated in the public interest,"[57] the public expects prices and the availability of energy to remain at an optimum level. Hence, state and federal agencies must be guided by statutes which reflect the public's expectations.

The third governmental concern is its "role as landowner."[58] The competing policies for this interest include "incentives to development, concern for federal revenue share, stimulation of small business, and worry over environmental consequences."[59] The final interest the government has in implementing energy policies is "special tax advantages, subsidies, loan guarantees, or prohibitions of competition."[60]

At the root of federal geothermal jurisprudence is the Geothermal Steam Act of 1970.[61] Noteworthy sections of the Act include the sections defining lands subject to geothermal leasing,[62] valuable byproducts of geothermal conversion,[63] and the possibility of federal exemption from state water laws.[64]

While some believe that the Act was largely a reaction to the "energy crisis of the early 1970s, and the emphasis on alternatives to imported oil,"[65] legislative history provides that the purpose of its enactment was to "permit exploration and development of geothermal steam and associated geothermal resources underlying certain public domain land[]."[66] Moreover, the Act envisioned geothermal resources as an energy source "with a potential for relatively pollution free, economical production of electric power to help overcome the increasingly critical power shortage confronting the Nation."[67]

The 1970 Act aimed to achieve two goals. The first goal was to encourage the "growing consciousness of environmental hazards and increasing awareness of the necessity to develop new resources to help meet the Nation's future energy requirements."[68] The second goal was to provide clear guidelines "to permit [geothermal] development on public lands."[69] That is, because most thermal areas had been found on public land, and other statutes (such as the mining and mineral leasing statutes) had proven insufficient , the 1970 Act sought to overcome these deficiencies in the law in order

53. Donald N. Zillman & Steven Naumann, *Geothermal Energy and National Energy Policy*, 14 NAT. RESOURCES L. 589, 593-96 (1982).

54. *Id.* at 593.

55. *Id.* "Congress has taken a broad view of health, safety, welfare, and commerce in passing legislation to provide for preservation of endangered species, protection of wild and scenic rivers, and regulation of harm to scenic visibility." *Id.* at 593-94.

56. *Id.* at 594.

57. *Id.*

58. *Id.*

59. *Id.*

60. *Id.* "Such programs often grow in unplanned ways[;] [as such,] [t]he development of hydro-electric and nuclear power . . . has relied heavily on federal dollars for dam construction, research, development, and demonstration." *Id.*

61. Geothermal Steam Act of 1970, 30 U.S.C. §§ 1001-1028 (1986). The Act defines geothermal steam and associated geothermal resources as "(i) all products of geothermal processes, . . . (ii) steam and other gases, hot water and hot brines resulting from water, gas or other fluids artificially introduced into geothermal formations; (iii) heat or other associated energy found in geothermal formations; and (iv) any byproduct derived from them." *Id.* at § 1001(c).

62. *Id.* § 1002

63. *Id.* § 1008.

64. *Id.* § 1021 (stating that "nothing in this chapter shall constitute an express or implied claim or denial on the part of the Federal Government as to its exemption from State water laws").

65. Zillman & Naumann, *supra* note 53, at 599.

66. H.R. REP. No. 91-1544, at 2 (1970), *reprinted in* 1970 U.S.C.C.A.N. 5113, 5113; *see also* Ethel R. Alston, Annotation, *Construction and Application of Geothermal Steam Act of 1970 (30 U.S.C.S. §§ 1001 et seq.), Pertaining to Leases of Government Lands For Development of Geothermal Steam Resources*, 40 A.L.R. FED. 814 (1978).

67. H.R. REP. NO. 91-1544, at 3.

68. *Id.* at 4.

69. *Id.*

to promote the development of geothermal resources.[70]

As discussed below, case law that emerged from the 1970 Act further defined the boundaries of geothermal resources.

B. Real Property and Water Aspects of Geothermal Energy

The property rights of an investor seeking to purchase or utilize a previously owned property for geothermal extraction are based on whether the property is (or was at one point) owned by the federal[71] or state[72] government, or by a private individual.[73] The core problem in the real property aspect of geothermal jurisprudence is whether the right to the thermal source has passed to the seller in the chain of title. This issue arises "whenever the owner in fee simple — quite often the federal or state government — convey[s] its interest in the surface of a tract of land, while reserving through various legal instruments its interest in 'coal, oil, gas, and other minerals' on or below the land."[74] A closely related issue is whether a geothermal source should be classified as a "mineral" or "water" source.[75]

The first case to address these issues was *United States v. Union Oil Co.*[76] The question before the court was "whether the mineral reservation in patents issued under the Stock-Raising Homestead Act of 1916,[77] reserved to the United States geothermal resources underlying the patented lands."[78] Before deciding on the question presented, however, the court had to determine whether geothermal resources are classified as "minerals."[79] The court concluded that "[a]ll of the elements of a geothermal system — magma, porous rock strata, even water itself — may be classified as 'minerals.'"[80] In reaching its conclusion the court reasoned that "the [SRH] Act's background, language, and legislative history offer convincing evidence that Congress's general purpose was to transfer to private ownership tracts of semi-arid public land . . . , but to retain subsurface resources, particularly mineral fuels, in public ownership."[81] Hence, "[t]he dual purposes of the [SRH] Act would best be served by interpreting the statutory reservation to include geothermal resources."[82] Accordingly, the court ruled that even though the Union Oil Co. is the "owner[], or lessee[] of owner, of lands" all geothermal sources are reserved to the United States because the "lands were public lands, patented under the SRH."[83]

To circumvent the court's ruling, Union Oil argued that while "mineral" may be reserved to the United States, "references in the Congressional Record to homesteaders' drilling wells and developing springs indicate that Congress intended title to underground water to pass to" the surface owner.[84] The court, however, rejected this line of argument because Congressional "references are to the

70. *Id.* at 5.

71. 30 U.S.C. § 1002. Under the Act, the Secretary of the Interior has the power to grant leases "for the development and utilization of geothermal steam and associated geothermal resources." The lands subject to lease include "(1) lands administered by…[the Secretary of the Interior], including public, withdrawn, and acquired lands, (2) …national forest or …lands administered by the Department of Agriculture…and (3) lands…conveyed by the United States subject to a reservation to the United States of the [geothermal resources." *Id.*

72. CAL. PUB. RES. CODE §§ 3700-3800 (West 2000) (providing the statutory procedure for the regulation of geothermal resources); *see also* CAL. PUB. RES. CODE §§ 6901-6925.2 (West 2000) (describing the scheme for leasing of public lands for geothermal extractions).

73. LINDSEY & SUPTON, *supra* note 31, at 81 (explaining that "the fee owner has rights in the valuable minerals and other substances under his land, and any other person seeking to acquire these substances must deal with him").

74. *Id.*

75. Owen Olpin & Barton H. Thompson, *Water Law and the Development of Geothermal Resources*, 14 NAT. RESOURCES L. 635 (1982) (providing that "[t]he fluid component of the geothermal resource has received a fair amount of attention. . . . The fluids have weighed in the litigation that has helped to determine 'ownership' when land has been subjected to a severance of mineral rights from surface rights")

76. 549 F.2d 1271 (9th Cir. 1977); *see also* Pariani v. State, 105 Cal. App. 3d 923 (1980) (reaching the same conclusion as the *Union Oil* court by applying the California statutes governing leases of public lands for geothermal extraction).

77. 43 U.S.C. §§ 291-298 (hereinafter "SRH Act").

78. *Union Oil*, 549 F.2d at 1272.

79. *Id.* at 1273 (noting that "[t]he [SRH] Act reserves to the United States 'all the coal and other minerals'").

80. *Id.* at 1273-74.

81. *Id.* at 1274.

82. *Id.*

83. *Id.* at 1273.

84. *Id.* at 1279.

development of a source of fresh water..., not to the tapping of underground sources of energy for use in generating electricity."[85] Hence, because the inherent characteristics of geothermal sources are distinguishable from a fresh water source, they cannot be classified as a "water" source.[86] Accordingly, rights to the geothermal sources remain in the "mineral" owner.

The next case that faced the issue of "whether geothermal resources belong to the owner of the mineral estate or the owner of the surface estate," was *Geothermal Kinetics Inc. v. Union Oil Co.*[87] While the surface owners, Union Oil, argued that "geothermal energy is not a mineral," the mineral owners, Geothermal Kinetics ("Kinetics") argued that "[s]ince...[a mineral owner] seeks to extract valuable resources from the earth, whereas the surface owner generally desires to utilize land..., the geothermal resources should follow the mineral estate."[88] The court, following and relying heavily on *Union Oil*,[89] held that "[i]n the absence of any expressed specific intent to the contrary, the scope of the mineral estate ..., includes the geothermal resources underlying the property."[90] Moreover, the court, in line with *Union Oil*, refused to categorize a geothermal source as a "water" source for several reasons. First, "[o]nly insignificant amounts of ground water enter the geothermal water system."[91] Second, the cost of extracting "geothermal water for a domestic water source is impractical."[92] Finally, "geothermal water contains toxic minerals making it unfit for surface, agricultural or domestic use [,and] [p]urification is not economically feasible."[93]

The holdings in *Union Oil* and *Geothermal Kinetics* clearly illustrate that geothermal sources are "minerals," owned by the mineral estate, and cannot be considered property of the surface estate by classifying them as "water" sources. However, even when the rightful owner of a geothermal source has been determined, there remains the issue of whether "mineral reservation should be construed broadly enough to encompass geothermal electric generating plant siting rights."[94] The court started its analysis by stating the "fact that geothermal energy must be exploited, if it is to be exploited at all, on the lands from which it is to be removed."[95] The court then reasoned that "Congress in enacting the... [SRH] Act contemplated that the...[surface user] would be required to submit to substantial use of that surface by those to whom the mineral estate was to be granted, so long as that use was for purposes reasonably incident to the mining or removal of minerals."[96] Similarly, the 1970 Act

> which authorizes the leasing of reserved geothermal resources, also authorizes the leasing of the right to build and operate power plants on the surface."[97] Accordingly, the court concluded that "power plant siting rights in lands patented under the 1916 [SRH] Act [and leased under the 1970 Act] were reserved to the United States.[98]

Although case law has answered several questions regarding the real property aspect of geothermal sources, extraction and utilization,

85. *Id.*

86. *Id.* at 1279 n.18 (relying in part on Owen Olpin, *The Law of Geothermal Resources*, 14 ROCKY MTN. MIN. L. INST. 123 (1968), which provides that "the surface owner [should] be entitled only to fresh waters that reasonably serve and give value to his surface ownership"). Salt water and geothermal steam and brines should be held the property of the mineral owner..., since the functions and values are more closely related." Olpin, *supra* at 140-141).

87. 75 Cal. App. 3d 56, 58 (1978).

88. *Id.* at 59.

89. *See supra* note 76 and accompanying text.

90. *Geothermal Kinetics*, 75 Cal. App. 3d at 62.

91. *Id.* at 63.

92. *Id.*

93. *Id.*

94. Occidental Geothermal, Inc. v. Simmons, 543 F. Supp. 870, 874 (N.D. Cal. 1982) (noting that the property in question was again subject to the SRH Act and the 1970 Act).

95. *Id.* (reasoning that "[i]f the steam cannot be used at the source, but rather must be conducted through pipes to distant electric generating facilities, thereby exposing it to friction and heat loss, it loses its practical utility as a source of electrical energy").

96. *Id.* at 875.

97. *Id.* at 878.

98. *Id.* at 874.

several attributes of geothermal energy mandate careful drafting of lease or sale agreements. A few examples include "possibility of premature reservoir depletion, … technological difficulties, … [r]esponsibility for high cost gathering systems and reinjection facilities."[99] Other examples include "inconsist[ency] from state to state in the fundamental characterization of the resource as mineral, water, or sui generis."[100] Hence, an investor seeking to lease or buy the rights to convert geothermal energy to electricity should keep the following points in mind during contract negotiation.

When leasing, the "lessee should obtain under the grant clause exclusive rights to the leased land for all purposes reasonably incident to prospecting, exploring, mining, drilling, extracting, taking, removing, using, storing, processing, concentrating, converting, producing, disposing and treating geothermal resources [including] byproducts."[101] Additionally, the lessee should have the "right(s) to install, construct, erect, maintain, operate, use, repair, replace, and/or remove facilities necessary or convenient to lessee's use of the leased lands."[102] Moreover, because the time period between discovering and converting geothermal energy to electricity will be several years, the optimum lease term should be fifty to ninety-nine years.[103] Other provisions should also specify royalties the lessor would receive.[104]

Similar to leasing, "contracts for the sale and purchase of high temperature geothermal steam utilized for the generation of electric power" should be highly specific.[105] Ideally, the purchaser should "contract for the seller's entire supply in a reservoir."[106] However, there are ways to divide the reservoir between the purchaser and the seller.[107] The contract should also contain several "conditions precedent to the obligations of the parties to perform."[108] Examples of such conditions include "quality and quantity" of the geothermal source, state or federal approval, securing the requisite permits and compliance with applicable environmental regulations.[109]

Another important provision in a geothermal sale contract is the plant siting terms.[110] The purchaser should be diligent when inquiring and investigating the rightful owner of the surface rights.[111] If the seller does not have rights to the surface estate, "contingency provisions [must be] inserted to govern the respective positions of the parties."[112] Alternatively, the buyer could require the seller to warrant his title as to the surface or mineral estate it purports to hold.[113]

C. Environmental Aspects of Geothermal Energy

Environmental concerns of converting geothermal energy to electricity revolve around the sufficiency of an environmental impact statement.[114] Determining the sufficiency of an environmental impact statement (EIS) depends on the approving government agency, which in turn depends on which agency or agencies have jurisdiction over the geothermal site.[115] Since extraction and conversion of geothermal energy may occur "on private lands, on

99. Robert L. Humphery & Clayton J. Parr, *Geothermal Sales Contracts*, 14 NAT. RESOURCES L. 613, 613 (1982).

100. E. Dale Trower, *Geothermal Leasing From the Developer's Point of View*, 14 NAT. RESOURCES L. 665, 665 (1982).

101. *Id.* at 665-66 (noting that if the lease is with the federal or state government, much of the terms are statutory defined). For private leases, however, provision specifying the rights of the parties are vital. *Id.*

102. *Id.* at 666.

103. *Id.* at 668-69.

104. *Id.* at 671-72 (noting that federal and most state statutes provide a royalty rate). For example, "geothermal resources used for electrical generation purposes carry . . . a [ten] percent rate". *Id.* at 671.

105. Humphery & Parr, *supra* note 99.

106. *Id.* at 615.

107. *Id.*

108. *Id.* at 617.

109. *Id.*

110. Recall that the rightful owner of the mineral estate may not necessarily own the surface estate. *See* discussion *supra* notes 97-101 and accompanying text.

111. *See* Humphery & Parr, *supra* note 99, at 629-30.

112. *Id.*

113. *Id.*

114. Zilmann & Naumann, *supra* note 53, at 602.

115. *See* Peter F. Windrem & Gary L. Marr, *Environmental Problems and Geothermal Permitting*, 14 NAT. RESOURCES L. 675, 675-76 (1982).

federal land, on federal mineral reserve land, on state land, [or] on state mineral reserve land,"[116] an investor should be aware of each agency's procedure. Moreover, approval and permits for geothermal projects depend on the outcome of the EIS.[117] This section only discusses requirements in federal and California jurisdictions.

The federal government requires all of its agencies to publish an EIS before approving "any major project significantly affecting the environment."[118] The statutory guideline for all federal agencies is set forth in 42 U.S.C. §4332.[119] It provides:

> (2) all agencies of the Federal Government shall....
> (C) include in every recommendation or report…a detailed statement…on
> (i) the environmental impact of the proposed action,
> (ii) any adverse environmental effects which cannot be avoided…, (iii) alternatives to the proposed action,
> (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
> (v) any irreversible and irretrievable commitments of resources which would be involved.[120]

When an agency prepares an EIS for the development of a geothermal source, it considers all of its six phases.[121] These phases are "exploration, test drilling, production testing, field development, power plant and power line construction, and full-scale operations."[122] Hence, when preparing an EIS, the responsible agency analyzes the environmental impact of the development on the geology, soil, water, air, noise, waste, health, transportation, land, aesthetics, socioeconomics and culture.[123] Once the EIS has been issued, the developer may either commence work or implement the agency's recommendations in order to obtain the agency's approval prior to development.

The same general guideline as the Federal EIS scheme is followed in California.[124] In fact, in applying the California Environmental Quality Act, California courts have relied upon "federal precedents as helpful authority in construing parallel provisions contained in the National Environmental Policy Act[125]… upon which the California Act was modeled."[126] Furthermore, as California courts have come to recognize, the "purpose of an…[EIS] is to provide concerned citizens and decision makers with information about the environmental consequences of project decisions before they are made."[127] Lastly, even though California laws require the developer to implement methods with the least adverse environmental impact,[128] "[i]f economical, social, or other conditions make it infeasible to mitigate one or more significant effects on the environment of a project, the project may nonetheless be carried out or approved at the discretion of the public agency if the project is otherwise permissible under applicable laws and regulations."[129]

116. *Id.* at 675.

117. Under federal jurisdiction, the agency issuing the EIS uses the federal Clean Air Act, 42 U.S.C. §§ 7401-7431, and the federal Clean Water Act, 42 U.S.C. §§ 1251-1387, as the standard for assessing air and water impact. If the proposal is subject to a state jurisdiction, state law equivalents are used.

118. Windrem & Marr, *supra* note 115, at 676.

119. 42 U.S.C. § 4332 (West 2000).

120. *Id.*

121. Sierra Club v. Hathaway, 579 F.2d 1162, 1165 (9th Cir. 1978).

122. *Id.*

123. *See, e.g.*, CAL. DEP'T OF WATER RESOURCES, SOUTH GEYSERS GEOTHERMAL POWER PLANT, SONOMA COUNTY, FINAL ENVIRONMENTAL IMPACT REPORT (1981).

124. CAL. PUB. RES. CODE § 21002 (West 1996) (providing in pertinent parts that "it is the policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects").

125. 42 U.S.C. § 4321.

126. Mount Sutro Defense Comm. v. Regents of Univ. of Cal., 77 Cal. App. 3d 20, 35 (1978).

127. Fairview Neighbors v. County of Ventura, 70 Cal. App. 4th 238, 242 (1999); *see also* CAL. PUB. RES. CODE § 21002.1(a) (setting forth the purpose of an EIR as to "identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided")

128. *Id.*

129. CAL. PUB. RES. CODE § 21002.1(c) (West 2000).

Therefore, under either federal or California jurisdictions, until and unless the appropriate agencies approve the environmental impact of the proposed geothermal project, the developer will be unable to implement any progress toward conversion.

D. Taxation Aspect of Geothermal Energy

Tax benefits for certain activities are often an indication of the government's support for those activities.[130] In the context of natural resources, the Internal Revenue Code[131] allows a taxpayer to deduct a percentage of the depleted resource in determining taxable income.[132] The deduction applies to the gross income derived from the property.[133] Under the Code, geothermal energy, which is defined as a "reservoir consisting of natural heat which is stored in rocks or in an aqueous liquid or vapor (whether or not under pressure),"[134] receives a fifteen percent depletion deduction.[135]

Other activities within the geothermal context may also be deductible. Specifically, Section 263(c) grants the taxpayer the "option to deduct as expenses intangible drilling and development costs[136] in the case of wells drilled."[137] These costs include:

All amounts paid for labor, fuel, repairs, hauling, and supplies, or any of them, which are used:

> 1) In the drilling, shooting, and cleaning of wells,
> 2) In such clearing of ground, draining, road making, surveying, and geological work as are necessary in preparation for the drilling of wells, and
> 3) In the construction of such derricks, tanks, pipelines, and other physical structures as are necessary for the drilling of wells and the preparation of wells for the production of geothermal steam or hot water.[138]

The Code does, however, place a limitation on the deductibility of intangible drilling and development costs. In Section 291(b)(1), if the taxpayer is a corporation, then the allowable deduction is reduced by thirty percent.[139] The amount that was not deducted can be ratably deducted over the sixty-month period beginning with the month in which the expense was incurred.[140]

If the intangible drilling and development costs are not deducted, then the operator[141] can elect to capitalize such expenses. The amounts capitalized are "recoverable through depletion insofar as they are not represented by physical property."[142] Moreover, the election to capitalize allows the taxpayer to deduct, as an ordinary loss, the costs of drilling a *nonproductive* well.[143]

In addition to the allowable deductions for the intangible drilling and development costs, the Code allows a deduction for costs incurred in "exploring for, or exploiting, geothermal deposits,"[144] These deductions, however, are

130. *See* discussion *supra* Part III.A.

131. Title 26 of United States Code [hereinafter Code].

132. I.R.C. § 611(a) (1986) (stating that "in case of mines, oil and gas wells, other natural deposits and timber, there shall be allowed as a deduction in computing taxable income a reasonable allowance for depletion and for depreciation of improvements"); *but see id*. §613(a) (providing that the "allowance for depletion under section 611 with respect to any oil or gas well shall be computed without regard to section 613").

133. *Id.* at § 613(a).

134. I.R.C. § 613(e)(2) (stating that a geothermal deposit "shall in no case be treated as a gas well for purposes of this section or section 613A, and this section shall not apply to a geothermal deposit which is located outside the United States or its possessions").

135. I.R.C. § 613(e)(1)(b).

136. 26 C.F.R. § 1.612-5(a) (2000) (intangible drilling and development costs include "all expenditures made by an operator for wages, fuel, repairs, hauling, supplies, etc., incident to and necessary for the drilling of wells and the preparations of wells for the production of geothermal steam or hot water.").

137. I.R.C. § 263(c).

138. 26 C.F.R. § 1.612-5(a); *see also id*. § 1.612-5(d) (listing expenditures that must be capitalized). Such costs include "expenditures by which the taxpayer acquires tangible property ordinarily considered as having a salvage value." *Id.*

139. I.R.C. § 291(b)(1).

140. I.R.C. § 291(b)(2).

141. 26 C.F.R. § 1.612-5(a)(defining an "operator" as "one who holds a working or operating interest in any tract or parcel of land either as a fee owner or under a lease or any other form of contract granting working or operating rights").

142. *Id.* § 1.612-5(b) (accounting for "expenditures for clearing ground, draining, road making, surveying, geological work, excavation, grading, and the drilling, shooting, and cleaning wells," as costs recoverable through depletion).

143. *Id.* § 1.612-5(b)(4).

144. I.R.C. § 465(c)(1)(E).

limited to the amount for which the taxpayer is at risk.[145] The Code considers the amount at risk as the money spent on the activity, the basis of the property or any borrowed amount for the pursuit of the activity.[146]

Another Code section that is applicable to geothermal energy is Section 1254.[147] It provides that the taxpayer will incur, as ordinary income, the amount that was deducted as intangible drilling and development costs if there is gain from the disposition of the geothermal property.[148] However, the amount incurred as ordinary income is the lesser of the gain realized from the disposition or the amount previously deducted as intangible drilling and development costs.[149]

A geothermal developer could also receive tax credit. Under Section 46 of the Code, the energy credit is an element of determining investment credit.[150] As specified in Section 48, energy credit is ten percent[151] of the "basis of each energy property placed in service during such taxable year."[152] In this context, energy property is "equipment used to produce, distribute, or use energy derived from a geothermal deposit…, but only, in the case of electricity generation by geothermal power, up to (but not including) the electrical transmission stage."[153]

IV. Financial Aspects of Geothermal Energy Power Plants

This Section discusses two related phenomena of financing a geothermal power plant. Part A provides a list of items that must be included in computing the cost of converting geothermal energy to electricity. In response, Part B discusses the available sources for financing geothermal projects.

A. Cost of Converting Geothermal Energy to Electricity

The cost of producing electricity from geothermal energy can be divided into three categories.[154] The first is research and development for technology.[155] The second is the cost of exploration and development of reservoirs; and the third is the construction cost of a power plant.[156] Since the second and third categories represent the major portion of the total cost, they are the focus of this Section.[157]

Exploration and development is perhaps the most important category of turning geothermal energy into electricity. Without sufficient geothermal energy to sustain the power plant for several years, there will be little, if any, return on the initial investment. As important and logical this step may sound, it has been overlooked. For example, from 1979 to 1984, California Department of Water Resources (CDWR) committed $50 million to developing and constructing a geothermal power plant without first ensuring that there was sufficient geothermal steam to sustain the plant for at least 30 years.[158] Poor analysis of available data on known geothermal reservoirs, failure to perform further investigation on site for additional geothermal sources, and commencing construction prior to assuring sufficient steam supply, caused the CDWR to commit a significant amount of money to a fruitless endeavor.[159]

145. I.R.C. § 465(a)(1).

146. I.R.C. § 465(b).

147. I.R.C. § 1254.

148. *Id.* § 1254(a)(1).

149. *Id.*

150. I.R.C. § 46(2).

151. I.R.C. § 48(2)(A).

152. I.R.C. § 48(a)(1).

153. *Id.* § 48(a)(3)(A)(ii).

154. Theodore E. Worcester & Catherine J. Boggs, *Capital for Geothermal Energy Projects*, 14 NAT. RESOURCES L. 713, 714 (1984).

155. *Id.*

156. *Id.*

157. After a power plant has been constructed, there are, of course, other costs; however, such costs are not discussed here since the essence of this Note is to determine whether producing electricity from geothermal energy is a sound investment.

158. AUDITOR GENERAL OF CAL., THE STATE COMMITTED $50 MILLION TO BUILD THE SOUTH GEYSERS GEOTHERMAL POWER PLANT WITHOUT ASSURING THAT SUFFICIENT STEAM WAS AVAILABLE (Mar. 1985).

159. *See id.* at 7-15.

To aid in estimating the cost of converting geothermal energy to electricity, several economic models have been suggested.[160] One model suggests the following equation for computing the capital required:

> F = [Fe + S fi Fe]fi + fi*[Fw + fwFw]
> . . .
> where "F" is the total fixed capital . . . , "Fe" is the equipment costs, "fiFe" cover the costs of piping, building structures, instrumentation, equipment installation, etc., and "fi" is a factor that accounts for indirect expenses such as engineering fees, contingency, escalation during construction and related costs . . . . "fi*" includes indirect expenses associated with discovery of the geothermal field, such as land acquisition, drilling exploratory holes . . . , surface exploration and contingencies. "Fw" is well cost and "fwFw" covers the cost of piping from the wellhead to the power plant and can represent fifteen to fifty-one percent of total well cost.[161]

Even though the list of expenses and costs are usually known, because the "geothermal industry, ..., is high-risk and capital intensive,"[162] determining the overall cost of producing electricity from geothermal energy remains a mystery.

B. Potential Sources of Capital

Sources for financing a geothermal project, much like any other project, include federal, state and private funding. In 1974, Congress found that "Federal financial assistance is necessary to encourage the extensive exploration, research and development in geothermal resources which will bring these technologies to the point of commercial application."[163] It also declared a policy to "encourage and assist in the commercial development of practicable means to produce useful energy from geothermal resources with environmentally acceptable processes."[164] To further its policy, Congress conceived a loan guaranty program which authorizes the Secretary of the Treasury to "enter into commitments to guarantee lenders against loss of principal or interest on loans made by such lenders to qualified borrowers."[165] The loan was limited to "(1) the determination and evaluation of ... [geothermal] base; (2) research and development with respect to extraction and utilization technologies; (3) acquiring rights in geothermal resources; (4) development, construction, and operation of facilities for the demonstration or commercial production of energy using geothermal resources."[166] Unfortunately, the loan guarantee program was terminated in 1993.[167]

Funding for a geothermal project could also stem from a state. For example, in California, "thirty percent of the revenues received and deposited in the Geothermal Resources Development Account"[168] may be used for undertaking research and development projects relating to geothermal resources assessment and exploration, and direct-use and electric generation technology.[169] This fund is available as a form of grants or loans to local jurisdictions or private entities.[170]

160. *See* STANLEY L. MILORA & JEFFERSON W. TESTER, GEOTHERMAL ENERGY AS A SOURCE OF ELECTRIC POWER: THERMODYNAMIC AND ECONOMIC DESIGN CRITERIA (1976); *see also* THOMAS MADDOCK, III, MANAGEMENT MODEL FOR ELECTRICAL POWER PRODUCTION FROM A HOT-WATER GEOTHERMAL RESERVOIR (1979).

161. MILORA & TESTER, *supra* note 160, at 79.

162. Worcester & Boggs, *supra* note 154, at 713-14.

163. 30 U.S.C. § 1101(10) (1986).

164. *Id.* § 1141(a).

165. *Id.* § 1141(b); *see also id.* § 1141(f) (defining "qualified borrower" as "any public or private agency, institution, partnership, corporation, political subdivision, or other legal entity which ... has presented satisfactory evidence of interest in geothermal resources and is capable of performing research or completing the development and production of energy in an acceptable manner").

166. *Id.* § 1141(b)(1)-(4).

167. *See id.* § 1143 (providing that "no loan guaranties shall be made, or interest assistance contract entered into, . . . after the expiration of fiscal year 1993").

168. CAL. PUB. RES. CODE § 3822(a) (West 1984); *see also id.* § 3820(a) (defining the Geothermal Resources Development Account as "All revenues received by the state pursuant to Section 35 of the Mineral Lands Leasing Act of 1930 (30 U.S.C § 191), [and] with respect to activities undertaken pursuant to the Geothermal Steam Act of 1970 [30 U.S.C § 1001 *et. seq.*]").

169. *Id.* §3823(a) (providing a list of activities for which the fund may be used).

170. *Id.* §3822(a).

Finding capital from the private sector may be the most challenging of all sources. Specifically, a developer seeking to convert geothermal energy into electricity must demonstrate the viability of the project. To make the investment more attractive, the developer might offer equity stock in its own company to investors, or it could form a partnership between itself and any potential investor.[171]

V. Conclusion

When all aspects of producing electricity from geothermal energy are considered, it may not constitute a sound investment. While geothermal energy has a lesser impact on the environment than other resources, the inherent characteristics of geothermal sources conjure unbearable risks. First, because technology in exploring geothermal sites has not yet been fully developed, underestimation of available energy to sustain a power plant for projected years is quite plausible. Even if a viable geothermal reservoir is found, because the power plant has to be in the vicinity, there remains the problem of whether the site is capable of accommodating a plant without considerable alteration. Moreover, since the sites for geothermal power plants are often remote, transferring electricity from the plant to the buyer is a considerable project all by itself.

There are also legal uncertainties. While federal courts have been consistent in applying the definition of geothermal energy, state laws are not as clear or well-defined. Beyond that, lack of litigation and precedent make each dispute a novel examination. Furthermore, because courts refrain from comparing geothermal energy to other natural resources (like gas or oil), there is even less guidance.

However, the right step in utilizing geothermal energy for electrical production has been taken. Since the main hurdle in the conversion of geothermal energy to electricity is estimating the life of a reservoir, federal and state support for further research and development is perhaps the optimal route for increasing geothermal uses. Tax incentives and credits for the same purpose are also a step in the right direction. Hence, unless and until more is known about geothermal energy, the inherent uncertainties of this environmentally friendly resource will not be as friendly to an investor or a developer.

171. *See* Worcester & Boggs, *supra* note 154, at 720-24.